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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Paper No. 11

Application Number: 09/987,202
Filing Date: November 13, 2001
Appellant(s): SCHEUMACHER ET AL.

John Darling
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 8/27/03.

(1) Real Party in Interest

A statement identifying the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

A statement identifying the related appeals and interferences which will directly affect or be directly affected by or have a bearing on the decision in the pending appeal is contained in the brief.

(3) Status of Claims

The statement of the status of the claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Invention

The summary of invention contained in the brief is correct.

(6) Issues

The appellant's statement of the issues in the brief is correct.

(7) Grouping of Claims

Appellant's brief includes a statement that all the claims do not stand or fall together and provides reasons as set forth in 37 CFR 1.192(c)(7) and (c)(8).

(8) Claims Appealed

The copy of the appealed claims contained in the Appendix to the brief is correct.

(9) Prior Art of Record

5,598,065	LAKOKSKY	1-1997
4,698,761	COOPER et al.	10-1987

Applicant's Admitted Prior Art, pages 1-2 of Applicant's own disclosure

(10) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

I. Claims 1, 2, 5, 6, 15-17, 19-21 and 23-30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lakosky (5,598,065) in view of Applicant's Admitted Prior Art (AAPA). (It is noted that there appears to be a numbering error/mistake in claim 16, and that claim 16 should depend from claim 15, not claim 14. Claim 16 has been treated as depending from claim 15 during the entire examination of this application, otherwise all of the limitations of claim 16 would lack antecedent basis.)

(a) Lakosky discloses all of Applicants' claimed invention (figure 1; col. 4, lines 21-23) but does not specifically disclose that a turbocharger or a CVT (continuously variable transmission) is used. AAPA discloses that it is well known to use a turbocharger in conjunction with a four-stroke engine and a CVT in order to increase power output and fuel efficiency of the engine and to reduce or prevent turbo lag (page 2, lines 5-7 and page 21, lines 16-18). It would have been obvious to one of ordinary skill in the art at the time of the invention to provide a turbocharger on the four-stroke engine of Lakosky as taught by AAPA in order to increase power output and fuel efficiency of the engine.

(b) Regarding claims 2 and15-17, all of the limitations recited are inherent properties of an engine and a turbocharger, e.g., that an engine has cylinders housed in combustion chambers which receive air through an inlet/throttle body and expel unused air/fuel mixture through an outlet and that turbochargers have an inlet inputting air from

the atmosphere through a duct and an inlet inputting exhaust gas from the engine to pressurize/compress the total volume of air therein, thereby turbocharging the air that is to be eventually input into the engine, and expelling non-used air through an exhaust system to a muffler (see, for example, the definitions of (i) internal combustion engine (ICE), (ii) cylinder, (iii) combustion chamber, (iv) throttle body, (v) turbocharger, (vi) exhaust system and (vii) muffler in the Road & Track Illustrated Automotive Dictionary, John Dinkel, Bentley Publishers, 2000.)

(c) Regarding claims 5, 6, 20, 21 and 26-29, the modified Lakosky snowmobile does not specifically disclose whether the air passage is positioned fore or aft of the engine, where the CVT is positioned relative to the turbocharger and what side of the engine the turbocharger, plenum and CVT are disposed on. It would have been obvious to one having ordinary skill in the art at the time the invention was made to put the air passage either fore or aft of the engine, to put the CVT on an opposite or adjacent side to the turbocharger or plenum, to put the turbocharger on a starboard or port side of the engine and to put the plenum and turbocharger on opposite sides of the engine for aesthetic purposes and design configuration requirements (and since Applicant has not disclosed any criticality to these mere placement decisions) since it has been held that rearranging parts of an invention involves only routine skill in the art. *In re Japikse*, 86 USPQ 70.

II. Claims 3, 7-10, 18, and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lakosky in view of AAPA as applied to claim 1 above, and further in view of Cooper et al. (4,698,761).

(a) The modified Lakosky device discloses all of Applicant's claimed invention except for a heat exchanger/intercooler connected to the turbocharger (by a duct) and a plenum connected to the heat exchanger/intercooler (by a duct), wherein the intercooler has an intake portion and an outlet portion connected by conduits. Cooper et al. disclose that a heat exchanger/intercooler connected to a turbocharger (by a duct - this is inherent) and a plenum connected to the heat exchanger/intercooler (by a duct - this is inherent) is well known for use with an engine to supply clean, compressed air to the cylinders of the engine (col. 7, line 53 to col. 8, line 11). It would have been obvious to one of ordinary skill in the art at the time of the invention to provide a heat exchanger/intercooler connected to the turbocharger and a plenum connected to the heat exchanger/intercooler on the modified Lakosky snowmobile as taught by Cooper et al. in order to supply clean, compressed air to the cylinders of the engine.

(b) Regarding claim 7, it is noted that it is inherent that intercoolers have an inlet and outlet connected by conduits (see, for example, the definitions of (i) intercooler and (vii) radiator in the Road & Track Illustrated Automotive Dictionary, John Dinkel, Bentley Publishers, 2000.)

(c) Regarding claims 8-10, Cooper et al. does not specifically disclose the positional arrangement of the intercooler. It would have been obvious to one having ordinary skill in the art at the time the invention was made to arrange the intercooler

normally, parallel or at an angle to the oncoming air flow engine for aesthetic purposes and design configuration requirements (and since Applicant has not disclosed any criticality to these mere placement decisions), since it has been held that rearranging parts of an invention involves only routine skill in the art. *In re Japikse*, 86 USPQ 70.

(d) Regarding claims 18 and 22, the modified Lakosky snowmobile does not specifically disclose the speed range for which the turbocharger pressurizes the air. It would have been obvious to one having ordinary skill in the art at the time the invention was made to make the speed range below 3000 rpm, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233.

(11) Response to Argument

Applicants' arguments regarding the rejection of claims 1 and 19 were presented on pages 14-19 and 25. Their main argument, which is the same as the argument presented in the amendment filed February 7, 2003, is that there is no suggestion or motivation to modify the snowmobile of Lakosky to include a turbocharged, four-stroke type engine. This is clearly, unambiguously and unequivocally not the case. The suggestion or motivation to modify the snowmobile of Lakosky comes directly from Applicants' Admitted Prior Art (in paragraph [0005] and [0006] of Applicants' specification), i.e., that it is known to use a turbocharger on a four-stroke engine, albeit outside the art of snowmobiles. Lakosky teaches a snowmobile which uses a four-stroke type engine. AAPA gives motivation for combining a turbocharger with a four-

stroke engine and for combining a CVT with a snowmobile. Applicants' mere combination of an admittedly well-known turbocharger and CVT on a four-stroke engine snowmobile is clearly met by the Lakosky in view of AAPA combination.

In response to applicant's argument that the examiner's conclusion of obviousness is based upon improper hindsight reasoning, it must be recognized that any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and does not include knowledge gleaned only from the applicant's disclosure, such a reconstruction is proper. See *In re McLaughlin*, 443 F.2d 1392, 170 USPQ 209 (CCPA 1971).

In response to applicants' argument that there is no suggestion to combine the references, the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). In this case, the motivation comes from Applicants' own admissions in the specification, namely that a turbocharger provides "increased power output and fuel efficiency" and that a CVT "can help reduce or prevent turbo lag" from a turbocharged engine.

Applicants' arguments regarding the rejection of claims 2 and 15-17 were presented (for the very first time) on pages 20-21 and 23-25. Applicants' main argument is that the examiner must provide a basis in fact and/or technical reasoning when relying on the theory of inherency. This basis was provided in the paragraph bridging pages 2-3 of the Final Rejection (Paper 7). Furthermore, for the convenience of the Board, relevant portions of The Road & Track Illustrated Automotive Dictionary have been cited in the above rejection of claims 2 and 15-17 to further provide proof of inherency of the relevant limitations. Again, it is noted that there appears to be a numbering error/mistake in claim 16, and that claim 16 should depend from claim 15, not claim 14. Claim 16 has been treated as depending from claim 15 during the entire examination of this application, otherwise all of the limitations of claim 16 would lack antecedent basis.

Applicants' arguments regarding the rejection of claims 5 and 6 were presented (for the very first time) on pages 21-23. Applicants' main argument is the *In re Japikse* decision does not apply to these claims. It is submitted that there is no criticality, whatsoever, to Applicants' claims that the air passage is positioned forward or aft of the engine to prevent significant heating of air within the air passage. This is evident from the fact that Applicants have themselves claimed that both arrangements are claimed to do the same exact thing, e.g., to prevent significant heating of the air within the air passage regardless of whether the passage is positioned forward *or* aft of the engine. Furthermore, it is submitted that Figure 12 of Lakosky appears to show the air passages positioned at least forward of the engine and that despite this showing it would be purely

a matter of design choice for aesthetic or design configuration requirement purpose to put the air passage forward or aft of the engine.

Applicants' arguments regarding the rejection of claims 20 and 21 were presented (for the very first time) on pages 27-28. Applicants' main argument is the *In re Japikse* decision does not apply to these claim. It is submitted that there is no criticality, whatsoever, to Applicants' claims that the CVT is positioned on the same side as the turbocharger or on an opposite side of the turbocharger. This is evident from the fact that Applicants have themselves claimed both arrangements and the claims are silent as to why these arrangements are beneficial or are for any other reason than pure design configuration. Furthermore, it is submitted that it would be purely a matter of design choice for aesthetic or design configuration requirement purposes to put the CVT on the same side or the opposite side of the turbocharger.

Applicants' arguments regarding the rejection of claims 23-25 were presented (for the very first time) on page 28-29. Applicants' state that the "[Final Rejection] does not identify any portion of Lakosky or AAPA that discloses that the turbocharger pressurizes the air prior to engagement of the CVT..." or that the engine is a V-twin two cylinder type engine or an in-line engine having multiple cylinders. This is clearly not true. The paragraph bridging pages 2-3 of the Final Rejection addressed the limitation that the turbocharger pressurizes the air as an inherent characteristic of a turbocharger. This limitation is necessarily taught by the very definition of a turbocharger. Furthermore, Lakosky teaches a two stroke or four-stroke engine. Again, The Road & Track Illustrated Automotive Dictionary must be referenced for a V-twin two-cylinder

engine and an in-line type engine, which are notoriously, well known in the art and which would be purely a design choice.

Applicants' arguments regarding the rejection of claims 26 and 27 were presented (for the very first time) on pages 29-30. Applicants' main argument is the *In re Japikse* decision does not apply to these claims. It is submitted that there is no criticality, whatsoever, to Applicants' claims that the turbocharger is disposed on a starboard or port side of the engine. This is evident from the fact that Applicants have themselves claimed both arrangements and the claims are silent as to why these arrangements are beneficial or are for any other reason than pure design configuration. Furthermore, it is submitted that it would be purely a matter of design choice for aesthetic or design configuration requirement purposes to put the turbocharger on a starboard or port side of the engine.

Applicants' arguments regarding the rejection of claims 28 and 29 were presented (for the very first time) on pages 30-31. Applicants' main argument is the *In re Japikse* decision does not apply to these claims. It is submitted that there is no criticality, whatsoever, to Applicants' claims that the plenum and CVT are disposed on the same side of the engine relative to one another or opposite sides of the engine relative to one another. This is evident from the fact that Applicants have themselves claimed both arrangements and the claims are silent as to why these arrangements are beneficial or are for any other reason than pure design configuration. Furthermore, it is submitted that it would be purely a matter of design choice for aesthetic or design configuration requirement purposes to put the plenum and CVT are on the same side of

the engine relative to one another or opposite sides of the engine relative to one another.

Applicants' arguments regarding the rejection of claim 3 were presented on pages 32-33. Applicants' main argument is that the heat exchanger of Cooper et al. is constructed and arranged such that heat from the pressurized air is dissipated therefrom to the water of the heat exchanger, not to the atmosphere via the heat conductive material of the heat exchanger. Firstly, it is noted that the heat exchanger of Cooper et al. is constructed and arranged such that hot exhaust gases pass through pipes which are surrounded by cooling water and then the heated water dissipates heat through the heat conductive material which the outside body of the heat exchanger is made of. This is how a heat exchanger or intercooler using a water as the cooling medium works. <u>The Road & Track Illustrated Automotive Dictionary</u> can be referenced. Applicants further argue that there is no motivation or suggestion to combine Lakosky, AAPA and Cooper et al. In response to applicant's argument \that there is no suggestion to combine the references, the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). In this case, the suggestion comes from the Cooper et al. reference itself as discussed in the rejection above. No duplicate recitation of that suggestion/motivation is needed here. In

response to applicant's argument that Cooper et al. is nonanalogous art, it has been held that a prior art reference must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the applicant was concerned, in order to be relied upon as a basis for rejection of the claimed invention. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). In this case, Cooper et al. relates to cooling of an engine. This is precisely the particular problem that is addressed in claim 3.

Applicants' arguments regarding the rejection of claims 7 and 11 were presented (for the very first time) on pages 34-35 and 37-38. Applicants' main argument is that the examiner must provide a basis in fact and/or technical reasoning when relying on the theory of inherency. This basis was provided in on pages 3-4 of the Final Rejection (Paper 7). Furthermore, for the convenience of the Board, relevant portions of The Road & Track Illustrated Automotive Dictionary have been cited in the above rejection of claims 7 and 11 to further provide proof of inherency of the relevant limitations.

Applicants' arguments regarding the rejection of claims 8-10 were presented (for the very first time) on pages 30-31. Applicants' main argument is the *In re Japikse* decision does not apply to these claims. It is submitted that there is no criticality, whatsoever, to Applicants' claims that intercooler is arranged generally normally, parallel or at an angle to the oncoming airflow. This is evident from the fact that Applicants have themselves claimed both arrangements and the claims are silent as to why these arrangements are beneficial or are for any other reason than pure design configuration. Furthermore, it is submitted that it would be purely a matter of design

choice for aesthetic or design configuration requirement purposes to arrange the intercooler normal, parallel or at an angle to the oncoming airflow.

Applicants' arguments regarding the rejection of claims 18 and 20 were presented (for the very first time) on pages 41-43. Applicants' main argument is that the *In re Aller* decision does not apply to these claims. It is well accepted that this decision provides teaching that discovering the optimum or workable ranges involves only routine skill in the art because it is submitted that this is considered mere optimization. It is further submitted this is all that is disclosed in claims 18 and 22.

Regarding the arguments pertaining to the rejection of claims 4, 12-14 and 30, claims 4, 12-14 and 30 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. The prior art fails to disclose that the plenum is connected to the air inlet and is constructed and arranged such that cyclically pressurized amplitude of the air from the turbocharger via the heat exchanger may collect therein in along with all of the rest of the recited limitations of claims 1-4.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

Matt Luby
Examiner
Art Unit 3611

Matthew Luby

M.I.
November 17, 2003

Lesley D Morris

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car, but most notably as a springing medium in the suspension.

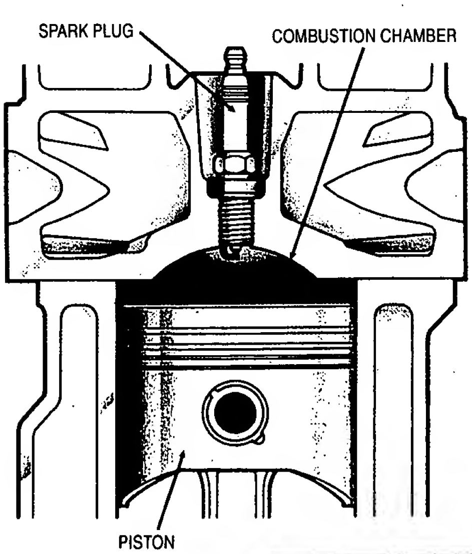
cold-crank rating The minimum current (measured in amperes in the United States) a fully charged battery can deliver for 30 seconds at 0 degrees Fahrenheit without falling below 7.2 volts.

cold plug See *heat range.*

column shift See *floor shift.*

combustion In an engine, the burning of the air-fuel mixture.

combustion analyser See *exhaust gas analyser.*



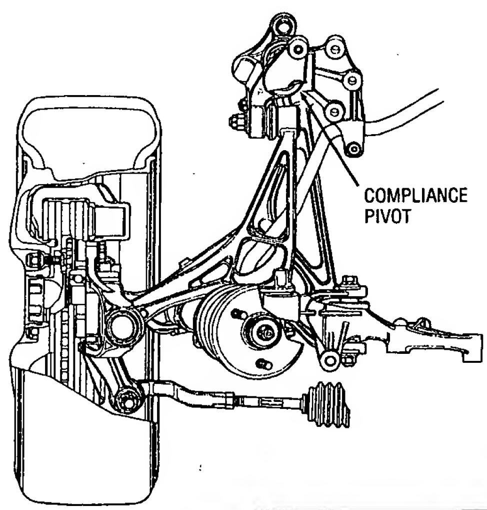
combustion chamber

combustion chamber The volume at the top of a cylinder, in the head and/or the piston top when the piston is at top dead center, in which combustion of the air-fuel mixture begins.

compact car By Environmental Protection Agency standards, a car enclosing 100–110 cu. ft. of passenger and luggage space.

compensating jet A fuel tube or pipe in the carburetor, into which air is admitted through one or more holes to compensate for a tendency of the main nozzle to deliver too rich a mixture as the air velocity through the carburetor increases. Also called *air bleed passage.* See illustration for *carburetor.*

compliance Term used to describe the "give" or resiliency designed into suspension bushings to help the suspension absorb bumps. Suspension designers achieve compliance by allowing the wheels to move slightly rearward



compliance mechanism

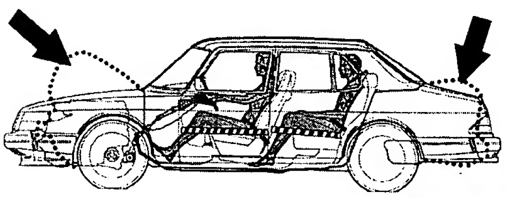
and up when they encounter a bump while at the same time constraining the wheels from lateral movements when cornering.

composite A combination of different materials. Plywood is a composite of woods; the term more frequently denotes materials made up of carbon and other fibers, layered to achieve specific properties.

composite headlight Non-sealed-beam headlight, with its shape freely chosen to permit

crumple zone See *crush zone.*

crush zone Front and rear ends of a car body designed for controlled absorption of collision energy to preclude or minimize deformation of the passenger compartment. Also called *crumple zone.* Also see *passive safety.*



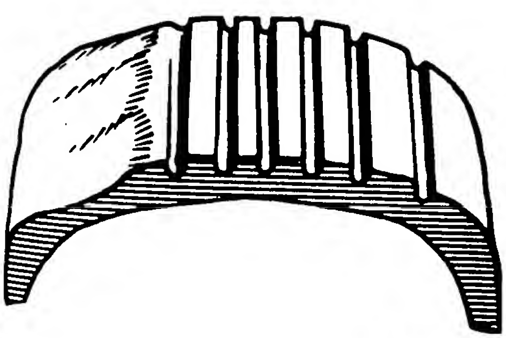
crush zone

cubic centimeter (cc) A metric measure of volume; engine displacement is typically measured in cubic inches, cubic centimeters, or liters. Multiplying cubic inches by 16.39 gives cubic centimeters; dividing cc by 1000 gives liters. Thus, 183 cubic inches equals 3000 cc, which equals 3.0 liters.

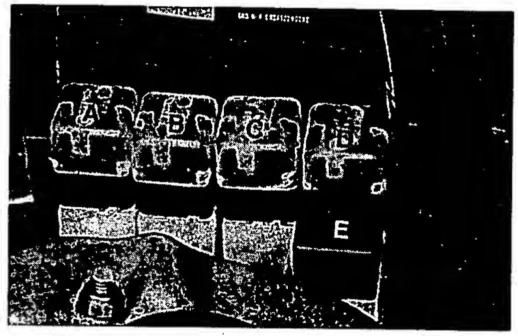
cubic inch See *cubic centimeter.*

cupping A tire wear condition caused by an unbalanced tire or faulty shock absorber; the excessive vibration causes the tread to be scooped out or "cupped" on one side of the tire.

curb-to-curb See *turning circle.*



cupping



cutout

curb weight Weight of a production car that is ready for the road, with fluid reservoirs (including fuel tank) full and all normal equipment in place but without driver, passengers, or cargo.

cutout A device that interrupts an electrical circuit; often automatic. Also known as a *circuit breaker, interrupter,* or *relay.*

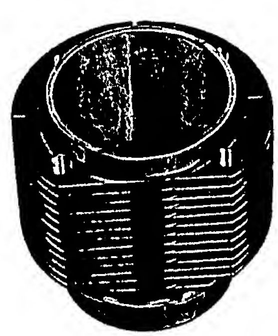
Also, a valve used to divert exhaust gases directly to the atmosphere instead of through a muffler.

CV joint See *constant velocity joint.*

CVT Continuously variable transmission. See *infinitely variable transmission.*

Cx See *coefficient of aerodynamic drag.*

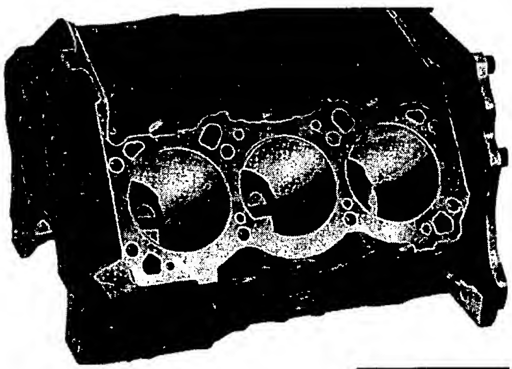
cylinder The hollow tubular structure in an engine's cylinder block in which the piston



cylinder

travels and combustion occurs. Also referred to as the *bore* or *barrel.*

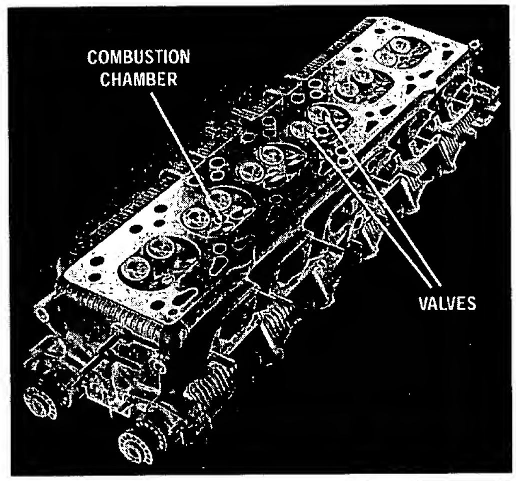
cylinder block The lower part of an engine, usually a casting and including the cylinders and crankcase, to which other parts are attached. Also called the *engine block* or *block.*



cylinder block

cylinder cutout A device or system that disables the power cycles of one or more cylinders of a piston engine, usually to reduce fuel consumption.

cylinder head That part of an engine, usually detachable, that attaches to the top of the cylinder block and seals the cylinders. It contains all or a portion of the combustion chambers; the water passages or air fins and oil passages for cooling and lubrication; and holds the spark plugs and, on contemporary engines, the valves.



cylinder head

cylinder liner See *liner.*

cylinder pressure The pressure in the combustion chamber at any given moment. Also see *mean effective pressure.*

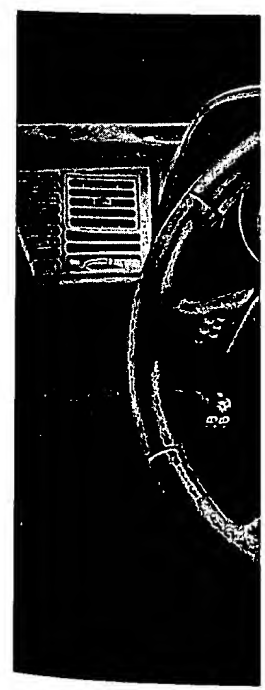
damper See *shock a*

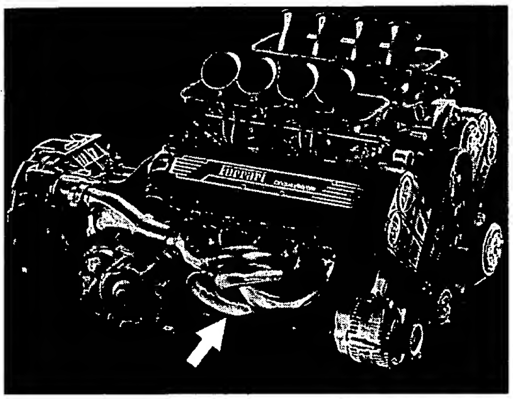
dash See *dashboard.*

dashboard A panel
shield, fitted across the
containing gauges, sw
for vehicle operation; a
panel or *dash.*

dash panel See *bulk*

dashpot A device cc
cylinder with a restrict
down or delay the ope
such as the throttle linl



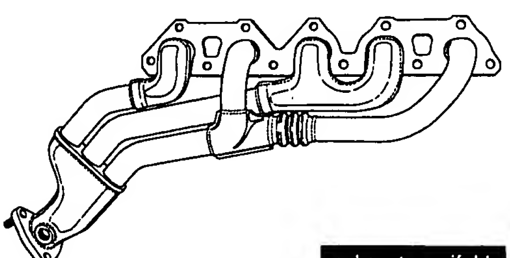


exhaust header

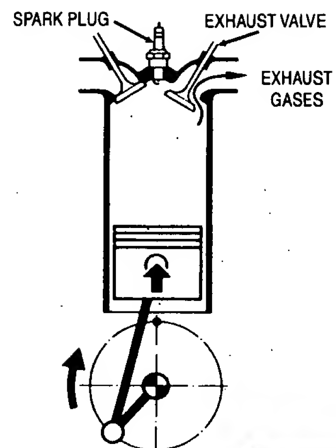
tion of the exhaust gas is picked up from the exhaust manifold, sent back to the carburetor, and reburned in the engine. Mixing exhaust gases with the fresh air-fuel mixture lowers combustion temperature and reduces the formation of oxides of nitrogen in the exhaust.

exhaust header Similar to an exhaust manifold, but usually made of steel tubing. Generally more efficient at extracting exhaust gases than a conventional cast iron exhaust manifold, resulting in less backpressure and greater power. See *exhaust manifold.*

exhaust manifold An assembly of tubes, usually of cast iron, that attach to an engine's cylinder head and provide paths through which burned gases from the cylinders can flow to the exhaust system.



exhaust manifold



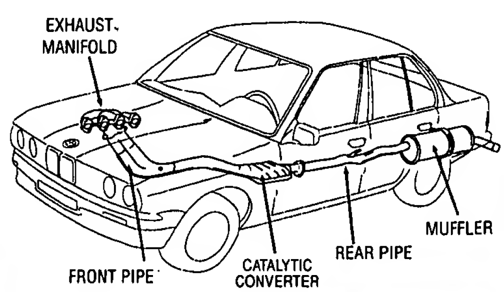
exhaust stroke

exhaust pipe Steel pipe that routes exhaust gases from the exhaust manifold or header to the muffler(s).

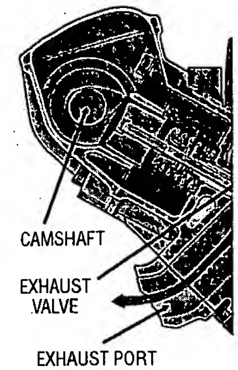
exhaust ports Passages in the cylinder head through which gases from the exhaust valves pass to the exhaust manifold.

exhaust stroke The upward fourth stroke of the four-stroke engine cycle, in which the piston moves from bottom dead center to top dead center, forcing the burned exhaust gases out of the cylinder.

exhaust system The pipes, resonators, and mufflers that carry the exhaust gases from the



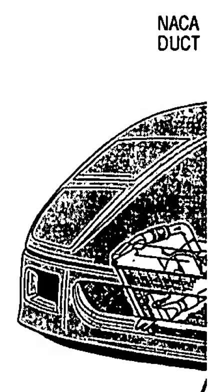
exhaust system

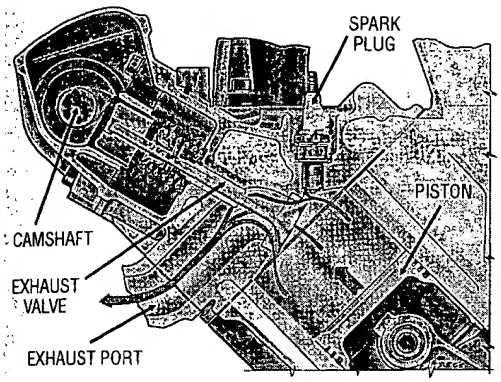


exhaust manifold int
ern emission-contro
system also includes
stringently emission
it may include a trap

exhaust valve A
the cylinder head th
gases out of the cylin
of the combustion c
pression and power s

expander ring Se





exhaust valve

exhaust manifold into the atmosphere. In modern emission-controlled gasoline engines the system also includes a catalytic converter; in stringently emission-controlled diesel engines it may include a trap oxidizer.

exhaust valve A camshaft-driven valve in the cylinder head that opens to allow burned gases out of the cylinder and closes to form part of the combustion chamber during the compression and power strokes.

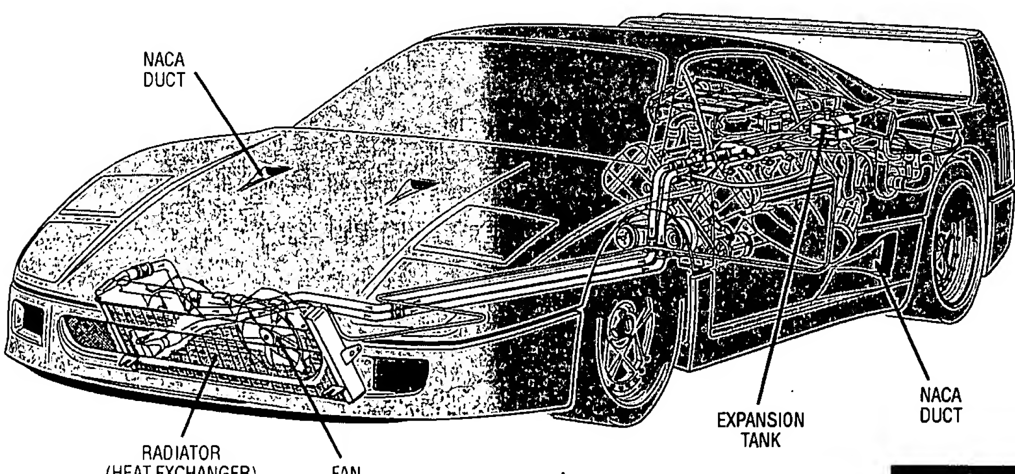
expander ring See *expansion ring.*

expansion plug A steel plug, slightly dished or cup-shaped, which when driven into place flattens out to fit tightly in its seat. In an engine block, expansion plugs (also called core plugs, core-hole plugs, or freeze plugs) are inserted in the holes in the casting through which the core was removed when the casting was formed. They open into cooling passages and thus provide pressure relief should the engine coolant freeze and expand.

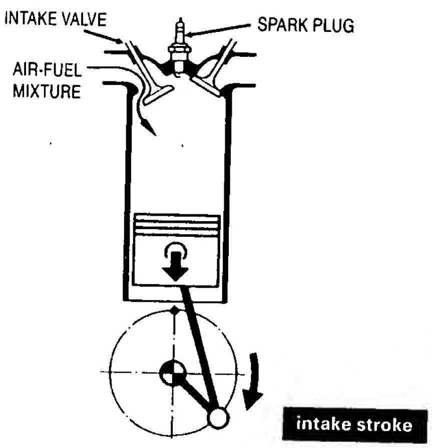
expansion ring A ring placed under a piston ring to increase ring pressure on the cylinder walls. Typically, an oil control ring consists of two thin rings or rails, with an expansion ring between them. The expansion ring pushes the rails up against the sides of the ring groove and out against the cylinder wall to seal and scrape oil from the wall. Also called an *expander ring.* Also see *oil control ring.*

expansion stroke See *power stroke.*

expansion tank In a sealed cooling system, a reservoir that connects to the radiator cap and that keeps the cooling system filled at all times. As the engine heats up, the coolant expands and a portion flows into the expansion tank. When



expansion tank



open and close orifices through which fuel is delivered to the individual injectors.

input shaft A shaft carrying a driving gear. In a transmission, for example, the shaft that receives power from the engine and transmits it to the gears.

insert For bearings, a replacement shell-type bearing made to extremely close tolerances and generally used for main and connecting-rod bearings.

For valves, replaceable valve seats made of hard, heat-resistant metal and screwed or shrunk into the cylinder head.

inside diameter See *rim diameter.*

instrument See *gauge.*

instrument cluster See *gauge cluster.*

instrument panel See *dashboard.*

intake manifold The assembly of tubes, usually of cast iron, aluminum, or plastic, through which the air-fuel mixture flows to the intake ports. In an engine with manifold fuel injection, the intake manifold carries air and fuel; with port fuel injection, it carries air only.

intake ports The passages in the cylinder head through which the air-fuel mixture flows from the intake manifold to the intake valves.

intake stroke The first stroke of the four-stroke cycle, during which the piston moves downward from top dead center to bottom dead center, creating a partial vacuum that draws the air-fuel mixture into the cylinder. Also called *induction stroke.*

intake valve A camshaft-driven valve in the cylinder head that opens to allow the air-fuel charge into the cylinder and closes to form part of the combustion chamber during the compression and power strokes. See *poppet valve.*

integral valve seat A valve seat machined into the cylinder head as opposed to one which is inserted into the head. Integral valve seats in a cast iron head can be locally heat-treated or hardened to increase their durability. Also see *insert.*

intercooler A small heat exchanger, similar to the radiator used in an engine's cooling system, that reduces the temperature of air delivered to an engine by a turbocharger or supercharger; the denser air-fuel mixture that results is more explosive when burned, which increases engine power. The reduced temperature also allows other power-increasing measures such as a higher compression ratio or more aggressive spark timing to be incorporated into an intercooled engine. An air-to-air intercooler uses air as the cooling medium; an air-to-water intercooler uses water.

interior noise The intensity (amplitude) of all sound heard inside a moving car, typically excluding that produced by the heating/air conditioning system or an audio system; usually measured in decibels (db) on the "A" weighing scale of a sound meter, thus expressed as dbA. Interior noise stems from the power train (intake hiss and exhaust boom from the engine, whining of transmission or differential gears), the road (dependent on road surface and relative roughness as well as the tires' size and tread design), and the car's shape and acoustical properties (the former determining the degree to which air is heard rushing over and around the car at speed, the latter perhaps amplifying the

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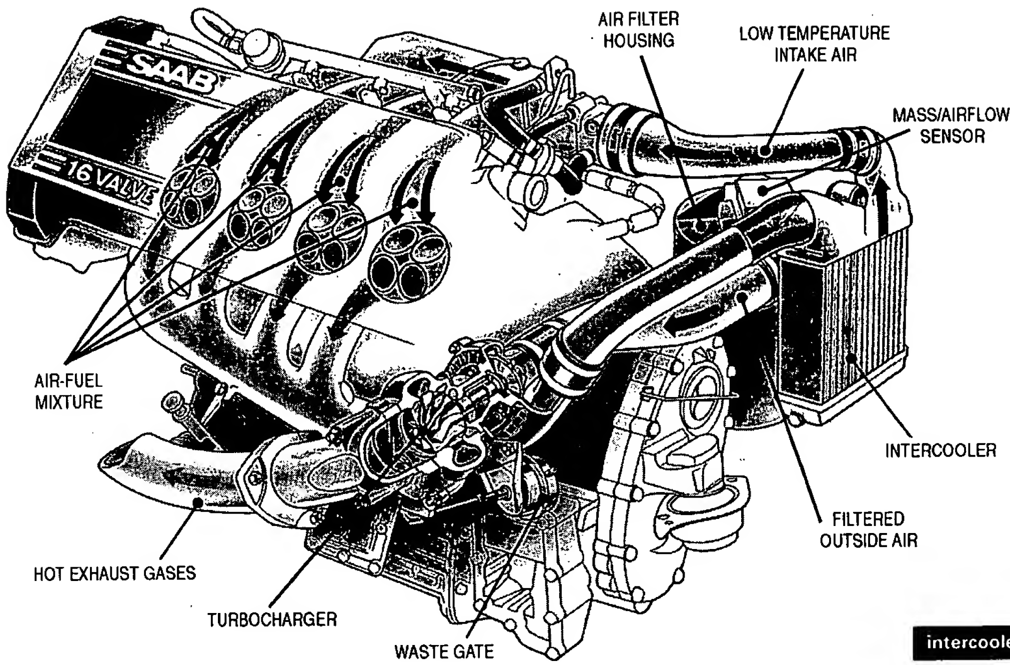


intercooler

exhaust note or road noise into a body "boom"). Interior noise is reduced by design factors that include sound insulation and isolating sources of vibration.

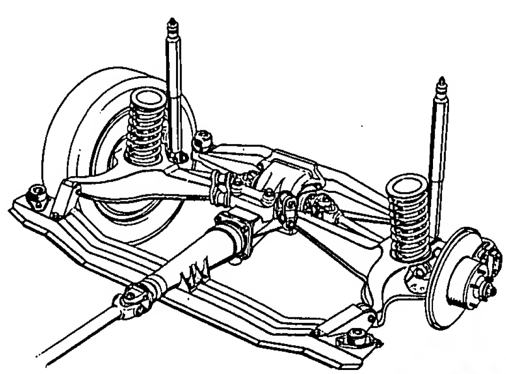
intermediate gear Any transmission gear between low and high. For example, in a four-speed transmission, second and third are the intermediate gears.

internal combustion engine (ICE) An engine in which fuel burns within cylinders or some other enclosed space, and the power of this combustion is converted directly into mechanical work. The working fluid consists of products of combustion of the air-fuel mixture itself. The Mazda rotary and Ferrari V-12, although quite different in design, are both internal combustion engines. Compare to *external combustion engine.*

interrupter See *cutout.*

involute gear teeth Gear teeth of slightly rounded profile that engage mating teeth under rolling, rather than sliding, friction, thus reducing power loss and wear. Nearly all gears used in automobiles have involute teeth.

IRS Independent rear suspension. See *independent suspension.*



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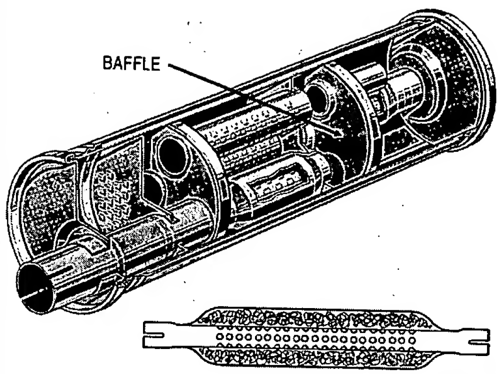


muffler

monobeam suspension A simple and rugged form of front suspension used in trucks. In a rear-drive truck, a simple beam axle supported by leaf springs is typically used. In a truck with 4-wheel drive, the single beam would consist of a live axle, one that transmits power by means of a differential and axle, again typically supported by leaf springs. Also see *beam axle* and *live axle*.

monobloc An engine block with the cylinder and crankcase in one integral casting.

monocoque A kind of car construction with a rigid, load-bearing skin or shell; especially efficient, though expensive, with a high strength-to-weight ratio. Monocoque race cars are as near to closed section as possible, with openings for the driver and engine. A model of a monocoque chassis is found in nature: the eggshell.

monoposto Italian for single-seat. See *single-seater*.

moonroof See *sunroof*.

motor A machine that converts electrical energy to mechanical energy, as opposed to an engine, which converts heat energy derived from some fuel into mechanical energy. The two words are often used synonymously.

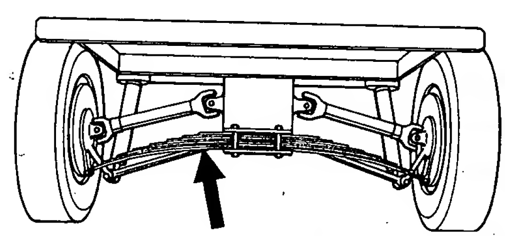
motor mounts See *engine mounts*.

Motor Octane Number (MON) See *octane number*.

mph See *miles per hour*.

muffler A chamber attached to an engine's exhaust pipe and fitted with baffles or porous plates that reduce or muffle the noise created by the exhaust.

multi-grade Oil formulated to flow more easily at low temperatures and/or lubricate better at high temperatures. The modification is accomplished with additives called viscosity-index improvers. Virtually all modern synthetic motor oils are multigrade. Also called *multiviscosity*. Also see *viscosity* and *viscosity index*.



multi-leaf spring

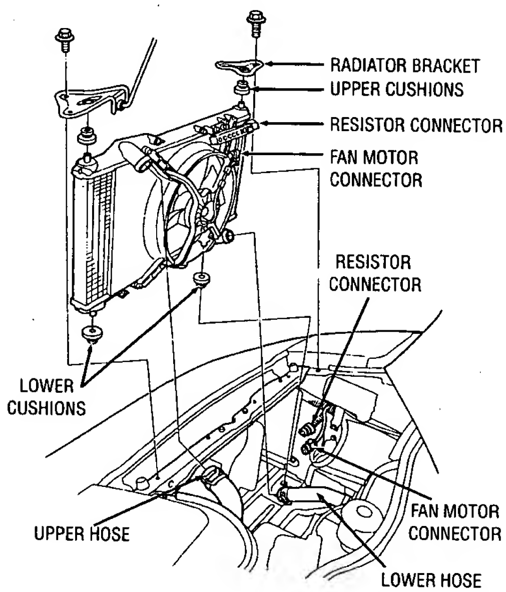
multi-leaf spring A leaf spring with several individual leaves mounted on top of one another and clamped together.

multi-link suspension A front or rear suspension system in which a number of links or arms (and no struts) are used to give longitudinal, vertical, and lateral support to the wheels. Because of the multiplicity of links, such a suspension can be tuned or adjusted to give excellent steering, braking, ride, and handling characteristics.

M

ally around 15 degrees) is added to make the tread area stiff and the relatively independent sidewalls flexible.

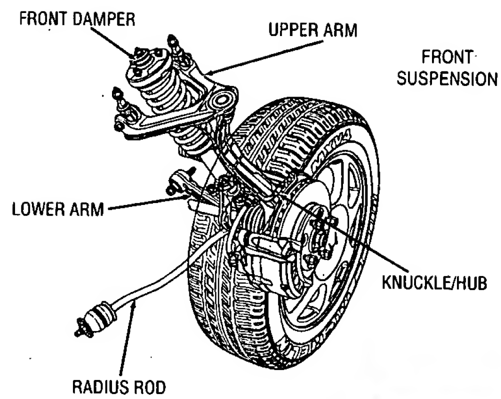
radial runout See *runout.*



radiator

radiator A heat exchanger connected to a car's engine, through which a mixture of water and antifreeze circulates. Air passing through the radiator transfers heat from the coolant to the atmosphere before the coolant is returned to the engine. A thermostat regulates the volume of coolant in order to maintain the engine at an optimum operating temperature. See *heat exchanger.*

radius rod A rod or arm used to locate a front or rear suspension component. When used to locate a live rear axle, the rods attach to the frame and to the axle to prevent fore–aft movement while allowing vertical motion. Attached to the



radius rod

frame in front of the axle, a radius rod is equivalent to a trailing arm; attached at the rear, it is equivalent to a leading arm.

ragtop A convertible.

rails See *fuel rail.*

rain gutter See *drip molding.*

rake adjustment See *seat-back angle.*

ram air A form of natural supercharging in which an intake duct, typically a hood scoop, pulls in air flowing over a moving car and forces it into the carburetor or fuel injection system.

ram effect See *resonance induction.*

ramp angle In profile, the angle created with a horizontal road surface by a line drawn from a car's tires to the lowest point of its front or rear overhangs; defines the steepness of transitions the car may traverse without scraping. A deep front spoiler, for instance, reduces the ramp angle.

read-only memory (ROM) See *memory.*

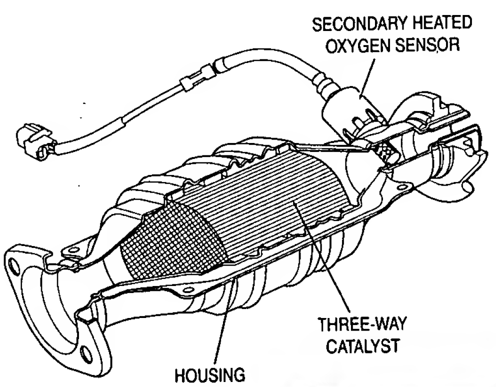
rear air dam See *air dam.*

rear deck The flat or mostly flat upper surface of a notchback body's trunk area, including the trunk lid and flanking rear fender surfaces.

a narrow temperature range, the thermostat closes off the coolant flow from the engine to the radiator until the engine has reached its operating temperature.

Other thermostats are used in the electrical circuit of a car's heating system to control the amount of heat supplied to the passengers; in the manifold heat-control system that preheats the air-fuel mixture going to the cylinders; and in the automatic choke.

three-way catalyst A catalytic converter that changes an engine's emissions of oxides of nitrogen, hydrocarbons, and carbon monoxide into less harmful products.



three-way catalyst

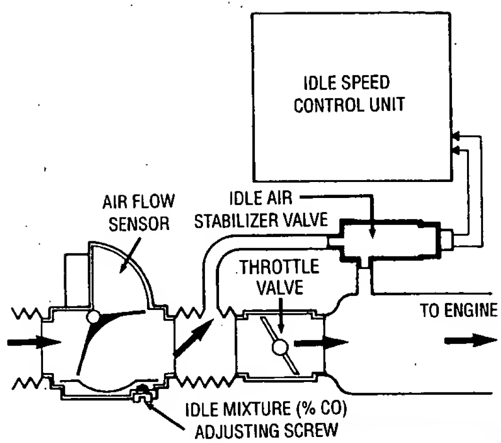
throttle The accelerator pedal. In the early days of the automobile the throttle was a hand control that governed the speed of an engine. Also see *accelerator*.

throttle body The section of an engine's intake system in which the throttle valve (butterfly) is located.

throttle-body injection (TBI) A system that injects fuel at the throttle body. See *fuel injection*.

throttle plate See *throttle valve*.

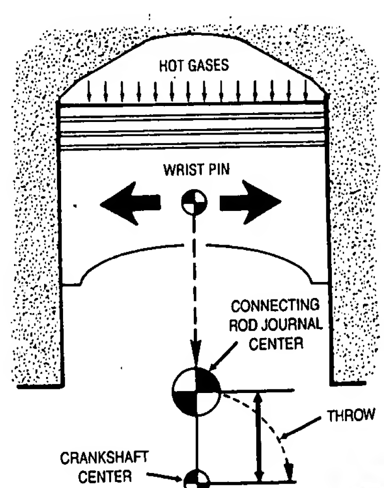
throttle valve A valve that varies the amount of air entering the intake manifold. Usually



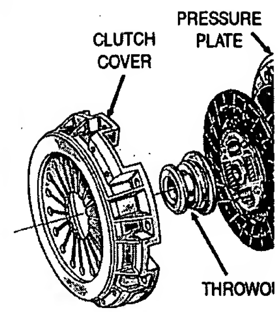
throttle body; throttle valve

consists of a flat round disc mounted on a shaft that can be tilted at various angles by means of a linkage from the accelerator pedal. Also called *throttle plate*.

throw Distance from the center of the crankshaft main bearing to the center of the connecting-rod journal. The piston stroke is twice the throw distance.



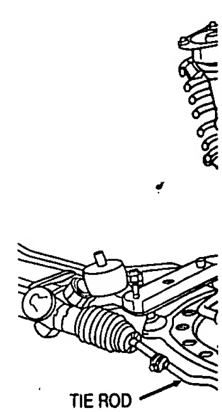
throw



throwout bearing T
moves into the release
clutch pedal, disengagi
connecting the engine fi
called *clutch release bear*

thrust bearing A be
sides that prevent a sh
shaft, from moving forw
engine crankshaft assem
to the two sides of the cr
tends to shift one way o
sides come up against
excessive end-to-end n
tion for *needle bearing*.

tie rod In a steering sy
pitman arm and the idle



trunk lid The lift-up panel at the rear of a notchback car that covers and provides access to the trunk. Because the luggage compartment of a rear-engine car (if any) is at the front, the trunk lid could also be called the hood of a rear-engine car. Some mid-engine models such as the Lotus Esprit have an engine access cover extended to double as the trunk lid. Also called the *deck lid.*

T-top See *T-bar roof.*

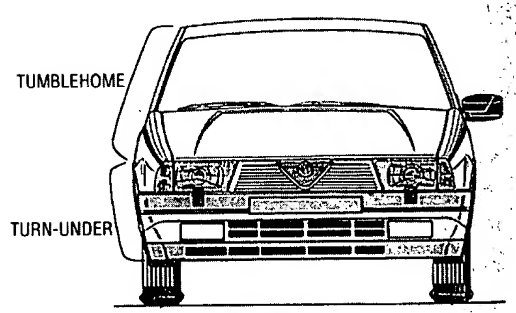
tube A tire's inner tube, which holds the air. Most current passenger car tires are a tubeless design, but many truck tires still use tubes. Also see *tubeless.*

tubeless A tire without an inner tube. Instead, an air seal is provided by a layer of special air-tight rubber which is applied on the inside of the tire casing and substitutes for the tube. The inflation valve, with rubber gaskets to assure airtightness, is fitted to a tubeless rim. The wheel flange must be in perfect condition because imperfections will cause air leaks between the tire and rim.

tuck-in A handling condition similar to trailing-throttle oversteer, but associated with front-wheel-drive cars. A tire can generate longitudinal (acceleration and braking) and lateral (cornering) forces or a combination of both. The front tires on a front-drive car, unlike those on a rear-drive vehicle, not only steer the car, but also provide the tractive effort that pulls the car. During hard cornering, applying power can cause the front tires to exceed their total traction limits. When this happens, the car will have a tendency to understeer or "run wide" through the corner. However, if the driver lifts off the throttle in the turn, the component of force driving the tires straight ahead will be redirected into cornering force, allowing the car to corner harder with less understeer. The driver will notice this increase in cornering force by the nose of the car "tucking in" toward the inside of the corner or by a reduction in understeer, which some drivers wrongly describe as front-wheel-drive oversteer.

tuck-under See *turn-under.*

tumblehome A styling term for the outward curvature from perpendicular of a car's upper body as viewed from the front or rear. Typically begins at the body's belt line. The opposite of *turn-under.*

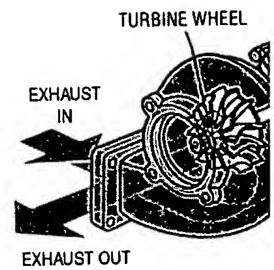


tumblehome; turn-under

tuned intake and exhaust systems Intake and exhaust systems that harness the pressure pulses and resonances inside the various chambers and passageways of the intake and exhaust manifolds to increase the flow of mixture into and the flow of burned gases out of the combustion chambers.

tune-up To perform careful and accurate adjustments to an engine (such as setting the timing, gapping the spark plugs, and adjusting the carburetor) for the purpose of obtaining optimum performance and lowest possible exhaust emissions.

turbine A wheel or disc with a series of radial vanes on one or both sides that, when acted on by the force of a gas or liquid, serve to rotate the wheel and thus impart motion to a shaft attached to it. Also, an engine using one or more turbines to produce power. Also see *torque converter.*

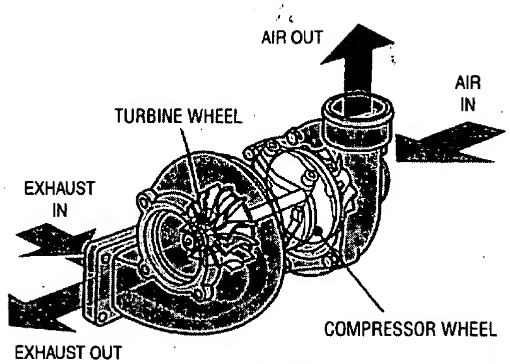


turbo See *turbocharge*

turbocharger A centı
ven by exhaust gases. It
driven turbine, a hou
drawn for compression
ven by the exhaust turb
tem that limits boost p
of internal damage.
Unlike a supercharg
not consume engine pov
of otherwise wasted ene
to increase an engine's p
the higher internal pres
feeding," compression
(and supercharged) eng
than those of their nor
parts in the interest of
Often shortened to *tur*

turbodiesel A turbo
diesel is inherently mo
ignition engine for tu
does not have a thrott

turbo lag Delayed
bocharged engine after
In a gasoline engine op
under minimal load, th
flow, and relatively l
through the turboch
demands power by ope



turbine; turbocharger

turbo See *turbocharger.*

turbocharger A centrifugal supercharger driven by exhaust gases. It consists of an exhaust-driven turbine, a housing into which air is drawn for compression by another turbine (driven by the exhaust turbine), and a control system that limits boost pressure to avoid the risk of internal damage.

Unlike a supercharger, a turbocharger does not consume engine power; instead, it makes use of otherwise wasted energy in the exhaust stream to increase an engine's power output. Because of the higher internal pressures involved in "force-feeding," compression ratios of turbocharged (and supercharged) engines are generally lower than those of their normally aspirated counterparts in the interest of prolonging engine life. Often shortened to *turbo*; also called a *blower.*

turbodiesel A turbocharged diesel engine. A diesel is inherently more suitable than a spark-ignition engine for turbocharging because it does not have a throttle valve. See *turbo lag.*

turbo lag Delayed response time in a turbocharged engine after the accelerator is pressed. In a gasoline engine operating at low speeds and under minimal load, the throttle is restricting gas flow, and relatively little exhaust gas flows through the turbocharger. Once the driver demands power by opening the throttle, it takes time for the increased exhaust-gas flow to bring the turbocharger to a speed where it can produce significant boost. Typically, the slower the engine is running when the driver steps on the throttle, the longer the turbo lag.

turbulent flow See *drafting* and *laminar flow.*

turn-in The transition between driving straight ahead and cornering. How quickly and smoothly turn-in occurs is a function of suspension stiffness, wheel and tire width, steering system design, and the car's moment of inertia.

turn indicator See *direction indicator.*

turning circle See *turning radius.*

turning diameter See *turning radius.*

turning radius The diameter (twice the radius) of the circle needed by a car to make a 360-degree turn. Turning radius is measured either curb-to-curb or wall-to-wall; the latter is always larger because it takes front-end overhang into account. Also called *turning circle* or *turning diameter.*

turn signal See *direction indicator.*

turns lock-to-lock The number of steering wheel rotations required to go from one extreme lock position to the other, i.e., full left to full right or vice-versa; an indicator of a car's maneuverability and handling response. See illustration for *steering lock.*

turn-under A styling term for the marked inward curvature from perpendicular of a car's lower body as viewed from the front or rear. Typically begins at the body's widest point. Also called tuck-under. The opposite of tumblehome.

T

twincam An engine with double overhead camshafts. Also see *overhead cam.*

two-plus-two (2+2) A coupe with two front seats (typically buckets) and nominal four-passenger carrying capacity but whose rear seating area is so limited as to be suitable only for small